DOCUMENT RESUME

ED 465 623 SE 066 345

AUTHOR	Gonzalez-Espada, Wilson J.; Oliver, J. Steve
TITLE	Making Puerto Rican High School Physics Contextual and Culturally Relevant: A Statistical Analysis of Influencing Factors.
PUB DATE	2002-01-00
NOTE	23p.; In: Proceedings of the Annual International Conference of the Association for the Education of Teachers in Science (Charlotte, NC, January 10-13, 2002); see SE 066 324.
AVAILABLE FROM	For full text: http://aets.chem.pitt.edu.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Cultural Influences; *Culturally Relevant Education; High Schools; *Physics; *Science Teachers; Teaching Methods
IDENTIFIERS	Puerto Rico

ABSTRACT

The purpose of this paper is to report some of the findings of 2 months of quantitative data collection associated with the study of context and cultural relevance in physics teaching in Puerto Rico. First, whether or not high school physics teachers use contextual and culturally relevant strategies in their classroom was examined. In addition, the factors were determined that influence the willingness of those physics teachers to modify their teaching methodology and physics curriculum so that the physics portrayed in the translated textbooks used in school became meaningful to Puerto Rican students. By meaningful, it meant it was contextual and culturally relevant to the Puerto Rican culture. (Author/MVL)

Making Puerto Rican High School Physics Contextual and Culturally Relevant: A Statistical Analysis of Influencing Factors

Wilson J. Gonzalez-Espada
J. Steve Oliver

MAKING PUERTO RICAN HIGH SCHOOL PHYSICS CONTEXTUAL AND CULTURALLY RELEVANT: A STATISTICAL ANALYSIS OF INFLUENCING FACTORS

Wilson J. Gonzalez-Espada, The University of Georgia
J. Steve Oliver, The University of Georgia

Introduction

Since education is a rather complex interaction that takes place in a specific socio-cultural context (Pai & Adler, 1997), there are challenges to the premise that through education, modern scientific knowledge can be brought into other countries with little concern with culture (Cobern, 1999). Science education researchers suggest that most developing countries are using "superficial adaptations of essentially Western curricula" as their educational system (Cobern, 1999, p. 16). They also report that, if we want science education to be meaningful and effective, it must aggressively consider the cultural context in which the educational system in embedded, and the society which it will serve (Cobern, 1999; Wilson, 1981). However, the school systems of different countries reflect different social systems and cultures and hence have idiosyncrasies which may be unique, or at least not shared by the country whose curricula they may be importing. Such importation, therefore, can be fraught with the dangers of irrelevancy and impracticality if due attention is not paid to the differences, and similarities of the two social systems and cultures involved (Court 1972).

Historically, the structure and nature of science curricula in developing countries has followed closely that of their colonial forbearers, becoming not much more than a highly decontextualized and theoretical curricula (Gray, 1999). In the case of Puerto Rico, it was a colony of Spain from 1493 to 1898, and a colony of the United States from 1898 to 1952. Some scholars even argue that Puerto Rico is still a quasi-colony of the United States under its

Commonwealth status. As a consequence, the colonial educational system of both Spain and the United States, which by being colonial imply the explicit or implicit domination through "proselytizing the oppressed to believe that they do indeed belong to the positions and classes they occupy" (Pai & Adler, 1997, p. 45), have shaped and influenced the Puerto Rican educational system for more than 400 years. Even though Commonwealth status allows Puerto Rico to have an autonomous form of government, which makes decisions about the educational system, there is still evidence of the strong influence of the United States into Puerto Rican education (Eliza-Colon, 1989; Negron de Montilla, 1990; Solis, 1994).

Since the school and home experiences of Puerto Rican students are often quite different from the school and home experiences of other Latin American students, generic science textbooks translated from English to Spanish may serve as barriers to learning. Puerto Rican students' experiences will also be different from the school and home experiences of U. S. students, who were the original targets of the English version of the textbook.

A quick look at the translated high school physics book used in Puerto Rico provides several interesting examples of decontextualized topics and their lack of local applications:

1. The textbook introduces the metric system of measurement, however does not provide conversion factors to English units, which are more prevalent. I know by experience that, without some comparison between English and metric units, Puerto Rican students are unable to have a conceptual picture of, for example, how long a decimeter is, or how much liquid there is a dekaliter.
2. Forces and vectors are discussed in a dry, conventional way. Puerto Rico has many historical buildings with varied architecture, which can be used as illustrations of the interaction of forces in a structure.

3. The textbook has many examples of physics concepts using sports such as tennis, golf, or archery. Puerto Rican students are more familiar with baseball, basketball, boxing, or track and field. For example, students can videotape an athlete on the long jump, and then using physics to analyze the images.
4. Simple machines are explained well on the text, but local applications are missing. There is a place near Ponce, Puerto Rico, in which the flow of water near a river moves a series of pulleys, levers, and other machines in a coffee plantation.
5. The topic of energy will surely be more meaningful to students if they are able to research energy problems Puerto Rico faces, such as alternative energy production and the geographical realities of the island. For example, I remember reading about a project to develop a solar air conditioner at the University of Puerto Rico in Mayaguez.
6. In the textbook there are some pictures that are completely irrelevant to Puerto Rican students. On page 194 there is a thermal picture of a U. S. home with a discussion about residential insulation. However, in Puerto Rico houses do not use this type of insulation. On page 241 there is a picture of a road damaged by water freezing and thawing during winter. However, In Puerto Rico the temperature never reaches 0°C! An example of a closed bottle filled with liquid in a freezer is much more familiar to Puerto Rican students that a freezing road.
7. Puerto Rico being an island presents incomparable opportunities to study waves in a relevant way. In addition, the characteristics of sound can be fully explained using local music instruments, like "guiro" and "cuatro". The textbook missed those opportunities.
8. The textbook present examples of static electricity. However, most static electricity experiments do not work as well in Puerto Rico because of the air's high humidity. My

demonstration using a Van der Graff generator were much less impressive that the one on this textbook.

Research on the contextual and cultural relevance of the science textbooks used in Puerto Rican schools has not been performed, but when done it may provide evidence that these components, now somewhat missing in the physics classroom, might increase student achievement in physics, might promote a more positive perception of physics among students, and might even promote enrollment in high school physics courses. This might produce more educated and scientifically literate citizens in general, and will strengthen the science foundation for those students who plan to go to college.

Another reason for studying the contextual and cultural relevance of the textbooks used in Puerto Rican schools is in terms of the high school physics teachers. This and future research in this area might provide evidence in favor of supplementary teaching resources that consider the culture and context of the students in presenting physics concepts. It is expected that teaching physics with attention to these factors will be less difficult and more enjoyable for teacher and students alike. Teachers might also combine their experience and knowledge to become active participants in the creation of these supplementary materials.

The purpose of this paper is to report some of the findings of two months of quantitative data collection associated with the study of context and cultural relevance in physics teaching in Puerto Rico. First, we examined whether high school physics teachers use contextual and culturally relevant strategies in their classroom. In addition, we determined what factors influence the willingness of those physics teachers to modify their teaching methodology and physics curriculum so that the physics portrayed in the translated textbooks used in school

become meaningful to Puerto Rican students. By meaningful, we mean contextual and culturally relevant to the Puerto Rican culture.

Methodology

Of the more than 120 physics teachers contacted during the eight-week period of data collection in Puerto Rico, ninety-two public high school physics teachers from the east and south of Puerto Rico participated in this study by returning the research instruments in person or by mail. These teachers were contacted by visiting their schools during the eight-week period of data collection in Puerto Rico. The participants were not randomly selected, making this a convenience sample. However, ninety-two high school physics teacher comprise about one third of the total population of interest, making this sample size undoubtedly representative of the total population of public high school physics teachers.

The quantitative portion of this study has three dependent variables and eleven independent variables. The dependent variables in this study are (a) the degree to which the Puerto Rican high school physics teachers modify the physics content presentation to make it more contextual and culturally relevant to the student population they serve, (b) the degree to which the Puerto Rican high school physics teachers modify their teaching methodologies to make them more contextual and culturally relevant to the student population they serve, and (c) the perceived degree of confidence in their physics knowledge.

In this study there are eleven independent variables, which are: (a) gender, (b) years of teaching experience, (c) years of experience as a physics teacher, (d) academic preparation in physics, (e) school size, (f) zone of school, (g) number of students per physics class, (h)

perceived freedom to change the physics curriculum, (i) perceived freedom to change their teaching methodology, (j) perceived quality of the physics textbook, and (k) political beliefs.

The independent variables were chosen based on several criteria. One group of these variables can be called demographic variables and provide general information about the participants, which might or might not be related to the dependent variables of interest. Examples of demographic variables are the participant's gender, age, and years of general teaching experience.

A second group of variables were specifically selected based on the experience, preparation, and knowledge of the Puerto Rican education and culture of the first author. They were considered important and with a strong potential for a significant relationship with the dependent variables. Examples of these variables are the teachers' years of experience teaching physics, academic preparation in physics, number of students per physics class, perceived freedom to change the physics curriculum and their teaching methodologies, perceived quality of the physics textbook, and the teachers' political/ideological beliefs.

A third group of variables were included to support the validity of the study by producing non-significant results purposefully. Examples of these variables were school size and school zone. Based on the centralized procedures the Puerto Rico Department of Education use to place teachers, no difference was expected between teachers in urban, suburban, or rural areas, or from teachers from small, medium-sized, or large schools. Statistically significant results in these variables might have placed the validity and reliability of the instruments in question.

In order to gather the quantitative data, three instruments were developed by the researchers. The first quantitative instrument was the Textbook Relevance Degree of Change Instrument (TRI). It uses a Likert-type numerical scale (between 1 and 5) and an additional N/A

option. The TRI is composed of 20 topics usually covered in a typical high school physics course (for example: motion, forces, momentum, gas laws, sound, light, etc.). The role of the teacher was to evaluate his/her degree of modification of those topics to make them more contextual and culturally relevant to their students.

In this instrument's scale, selecting "1" implied that the teacher did not make any modification in the way they present physics concepts discussed in the textbook to account for the characteristics and experiences of Puerto Rican students. On the other hand, selecting "5" implied that the teacher used examples with common materials and familiar situations, applied the physics concepts to problems of local relevance, included components of the Puerto Rican culture in the explanations, and connected the physics concepts with Puerto Rican realities. Intermediate numbers are assumed to represent a linear transition between the two extremes. The N/A option will be selected only if the teacher does not teach that particular topic in his/her class.

In addition, a section is provided for teachers to evaluate their degree of confidence of the different physics topics presented, which is the second dependent variable. This variable was also measured on a 1 to 5 scale, in which selecting "1" implies that the teacher is completely unsure (total lack of confidence) about his physics knowledge, "2" implies that the teachers is partially unsure (partial lack of confidence) about his physics knowledge, "3" implies that the teacher is undecided about his confidence in his physics knowledge, "4" implies that the teacher is partially sure/confident of his physics knowledge, and"5" implies that the teacher is completely sure/confident of his physics knowledge.

The second quantitative instrument was called the Teaching Methodology Degree of Change Instrument (TMI), created to measure the third dependent variable. It also uses a Likert-type numerical scale (between 1 and 5) and an additional N/A option. The TMI is composed of

19 common teaching techniques used by teachers in a typical high school course (for example: lecture, demonstration, laboratory, group projects, etc.). The role of the teachers is to evaluate his/her degree of modification of those teaching techniques to make them more contextual and culturally relevant to the needs, experiences, and particularities of their students.

In this instrument's scale, selecting "1" implied that the teacher did not make any modification in their teaching methodologies to account for the characteristics and experiences of Puerto Rican students. On the other hand, selecting "5" implied that the teacher adapted his teaching methods to include problems and situations of local relevance, used materials and equipment readily available in the community, and included components of the Puerto Rican culture. Intermediate numbers are assumed to represent a linear transition between the two extremes. The N/A option will be selected only if the teacher does not use a particular teaching technique in his/her class.

The third quantitative instrument was called the High School Physics Teacher's Demographics Survey (DS). It was created to gather information about the independent variables in a fast and efficient way.

One of the main purposes of quantitative research is to quantify variance and to separate it into different portions, which usually correspond to the independent variables of the study (Wiersma, 2000). In this case, one-way analysis of variance is used as the main statistical technique. Analysis of variance is an inferential statistical procedure used to detect significant differences in means for two or more populations or groups of people with different characteristics. It tests the null hypothesis that different groups' means (for a given dependent variable) are equal. The data available provided thirty one-way tests between the independent and dependent variables.

For this study, all possible efforts were made to maximizing its expected power within the limitation of the researchers. Diekhoff (1996) identified four main factors (choice of level of significance, choice of sample size, size of the effect of interest, and error variance in the population). Of those, we focused on the first two: choice of level of significance and choice of sample size.

When researchers adopt a liberal level of significance, they are making it easier for the statistical test to find significant differences, even if they are not that large. By increasing level of significance, we can increase the sensitivity of the test (power). Due to the nature of this study and the limitations of quantitative educational research, choosing a conservative significance level, like 0.01 or 0.001, is not recommended. Also, choosing a liberal significance level, like 0.1 or 0.2, is not a good option because of the number of univariate and multivariate tests performed and the risk of chance capitalization. As a way to both increase power and acknowledge the limitations of my study, a significance level of 0.05 was selected, although this significance level was considered somewhat flexible under special circumstances.

A difference of a given amount is more likely to be found significant if the researchers have a large sample size. A large sample size also reduces the sample variance. As a consequence, statistical tests are more able to recognize two variances as different. By increasing the sample size, we can increase the sensitivity of the test (power). During the first author's visit to Puerto Rico, he contacted as many teachers as possible to gather the largest possible sample size. At the end of data collection, the sample size consisted of 92 teachers, or about 1/3 of the total population of public high school physics teachers in Puerto Rico. Such a large proportion of participants out of the total population is an excellent indication that the study will be sensitive enough to make population generalizations.

Findings

For the following univariate tests, the statistical technique used was simple analysis of variance (ANOVA) to detect mean difference for the groups compared, with a confidence level of 0.05. In addition, the Levene test was performed to examine the assumption of homogeneity of variance. ANOVA works well even when this assumption is violated, except in the case where there are unequal numbers of subjects in the various groups. Since this is the case for some tests, a significant result for the Levene test will automatically discard that particular test. All the statistical analyses were accomplished using SPSS (Statistical Package for the Social Sciences), version 9.0.

Test 1 (S): Average Change in Physics Content Presentation as a Function of the Average Number of Students Physics Teachers Have in their Groups

Based on a sample size of 90 participants, the statistical analysis showed an overall significant relationship between the average change in physics content presentation and the number of students per class section ($F = 3.565$, $p = 0.033$). This result suggests that the larger the number of students in a classroom, the less change the teachers made in their content presentation (use of examples with common materials and familiar situations, application of physics concepts to problems of local relevance, inclusion of components of the Puerto Rican culture in their explanations, connection of the physics concepts with Puerto Rican realities). Interestingly, the post-hoc pair-wise comparison failed to identify any two means that are statistically different. Table 1 summarizes the descriptive data for this test.

Table 1:

Sample Size, Mean Change in Physics Content Presentation and Standard Deviations for the Number of Students Physics Teachers Have in their Groups

Students per group	Sample size	Arithmetic mean	Standard deviation
0 – 10 students	2	na	na
11 – 20 students	12	3.8398	0.8697
21 – 30 students	49	3.6354	0.1939
31 – 40 students	29	3.0403	1.1335

This test showed a significant relationship between the number of students physics teachers have in their class sections and the mean change they make to the physics content presentation to make it more contextually and culturally relevant, even after collapsing the first two categories into a single one to increase the statistical power of the test ($F = 3.898$, $p = 0.024$). This significant result suggests that the more students physics teachers have in their classes, another factor or factors associated with this increase affect the teachers' inclusion of context and culture in the physics class. As a consequence, less time is spent using examples with common materials and familiar situations, applying physics concepts to problems of local relevance, including components of the Puerto Rican culture in class, and connecting the physics concepts with Puerto Rican realities. In all cases, the mean change reported is more than three, which is indicative that even teachers with a large number of students per class are able to make some changes to their physics content presentation along more relevant lines.

Test 2 (S): Average Change in Physics Content Presentation as a Function of the Perceived Freedom of the Teacher to Modify their Teaching Methodology

Based on a sample size of 87 participants, the statistical analysis showed that there is not a statistically significant difference in the average change in physics content presentation across all categories ($F = 3.073$, $p = 0.052$). However, since the obtained p value is so close to the confidence level selected, plus the fact that 0.05 is nothing more than an arbitrary cutoff point, for discussion purposes this test will be considered significant. More detailed analyses, especially pair-wise comparisons among the means for the different categories, failed to identify any two means that are statistically different. Table 2 summarizes the descriptive data for this test.

Table 2:

Sample Size, Mean Change in Physics Content Presentation and Standard Deviations for the Perceived Freedom of the Teacher to Modify their Teaching Methodology

Perceived freedom	Sample size	Arithmetic mean	Standard deviation
No freedom	5	2.2922	1.0769
Some freedom	52	3.4905	1.1279
Absolute freedom	30	3.5755	1.0121

This test revealed that there is not a significant relationship, at the 0.05 confidence level, between whether teachers believed they have freedom to select and modify their teaching methodology and the reported mean changes in their physics content presentation to make it contextually and culturally relevant. However, there is a significant relationship at the 0.1 confidence level. In fact, the p value from the test is so close to 0.05 that it might be considered significant for discussion purposes. The reported mean for those teachers who think they have no say on their teaching methodologies (approximately 2.29) is very low compared to the reported mean for teachers who think they have some or all freedom in choosing and modifying their

teaching methodologies (3.49 and 3.58 respectively). This is also consistent with the beliefs versus actions framework in the physics classroom.

Our experience is that the Puerto Rico Department of Education has no specific guidelines suggesting a group of teaching methodologies over others. Teachers, as education professionals, are left to judge and decide on the teaching methodologies that they want to use. However, we understand why some teachers think they have no freedom to modify their teaching methodologies. For one, public schools tend to be traditional, focusing on content coverage by lecturing, discussion and other teacher-directed means. In addition, it is easier, more objective and evidentiable (for legal purposes) to assess students on content knowledge by testing what was given by the teacher. Teachers might feel that they must (as opposed to "should") follow teacher-directed means of instruction.

Test 3 (S): Average Change in Physics Content Presentation as a Function of Teacher's Years of Experience Teaching Physics

Based on a sample size of 90 participants, the statistical analysis showed that there is not a statistically significant difference in the average change in physics content presentation across all categories ($F = 2.410$, $p = 0.055$). However, since the obtained p value is so close to the confidence level selected, plus the fact that 0.05 is nothing more than an arbitrary cutoff point, for discussion purposes this test will be considered significant. More detailed analyses, especially pair-wise comparisons among the means for the different categories, failed to identify any two means that are statistically different. Table 3 summarizes the descriptive data for this test.

Table 3:

Sample Size, Mean Change in Physics Content Presentation and Standard Deviations for the "Years of Experience as Physics Teacher" Category

Yrs. exp. as physics teacher	Sample size	Arithmetic mean	Standard deviation
0 – 5 years	42	3.1558	1.1772
6 – 10 years	22	3.7798	1.0949
11 – 15 years	9	3.5981	0.9047
16 – 20 years	11	3.6631	0.7068
21 – 25 years	6	4.3022	0.7526
26 – 30 years	1	na	na
More than 30 years	1	na	na

This test showed that, although there is not a significant relationship at the 0.05 level between the mean change in physics content presentation and the participants' years of experience as physics teachers, there is a relationship at the 0.10 level. Since the p value for this test is so close to 0.05, I think it is worth mentioning, especially the appreciable difference in reported mean between novice teachers (approximately 3.16 for teachers with less than five years of experience) and veteran teachers (approximately 4.30 for teachers with 21 – 25 years of experience).

This difference between novice and veteran teachers might suggest that teachers learn to make their physics content presentation more contextual and culturally relevant from experience teaching physics classes, since the reported means started low at the novice level and keep increasing from the third category on. We do not have a good reason to explain why the reported mean for the 6 – 10 years of experience category is different from the overall trend.

To increase the statistical power of the test, the last three categories were collapsed into one new category (21 or more years of experience) and a new analysis of variance was performed. It failed to detect significant differences at the 0.05 level ($F = 2.639$, $p = 0.054$), but since the new p value is almost identical to the value obtained from the original test, the argument presented above is still valid. Since the obtained p value is so close to 0.05, and this confidence level is arbitrary, for discussion purposes this test will be considered significant. In general, these tests suggest that physics teachers do make changes to their physics content presentation, regardless of years of experience teaching physics, although there is a trend for veteran teachers to make more changes compared to novice teachers.

Test 4 (S): Average Change in Teaching Methodology as a Function of Teacher's Gender.

Based on a sample size of 92 (48 males and 44 females), the statistical analysis found that the average change in teaching methodology for males was 3.99 with a standard deviation of 0.7812. For females, the average change in teaching methodology was 3.48 with a standard deviation of 0.9678. The difference in means between males and females was significant ($F = 7.802$, $p = 0.006$), which suggests that male physics teachers make more adaptations to their teaching methods to include problems and situations of local relevance, use more materials and equipment readily available in the community, and include more components of the Puerto Rican culture, compared to female physics teachers.

Since the academic preparation for becoming a science teacher might be similar for both genders, we theorize that factors related to their classroom experience are responsible for this difference, but there are no data to support this or any particular explanation for the significant result. Unfortunately, the data gathered do not provide any clues about this assertion; only future research might explore this topic more deeply.

Test 5 (S): Average Change in Teaching Methodology as a Function of the Number of Semesters of Physics Courses Teachers Have.

Based on a sample size of 91 participants, the statistical analysis found no statistically significant difference in the perceived degree of confidence in the teacher's physics knowledge across all categories ($F = 1.658$, $p = 0.142$) when using the original categories. However, new statistical analysis with fewer categories found a significant relationship between these variables ($F = 3.050$, $p = 0.033$), which suggest that teachers who have taken more physics courses make more changes to their teaching methodologies compared to teachers who are less academically prepared in this subject area. Table 4 summarizes these new results.

Table 4:

Sample Size, Average Change in Teaching Methodology, and Standard Deviations for the Number of Semesters of Physics Courses Teachers Have (Collapsed Data)

No. semesters of physics	Sample size	Arithmetic mean	Standard deviation
0 – 2 semesters	24	3.2827	1.0796
3 – 5 semesters	29	3.9137	0.7668
6 – 11 semesters	23	3.9650	0.8425
12 + semesters	15	3.7817	0.5713

This test originally revealed that there was not a statistical relationship between the teachers' mean changes to their teaching methodologies to make them more contextual and culturally relevant and their academic preparation in physics. This finding is paradoxical in a sense, because one might think that subject content preparation and pedagogical preparation are two independent realms. Evidence of this is the fact that in Puerto Rico science teachers take their content area courses from the academic departments and their secondary or science

pedagogy courses from the College of Education. We think that these last three tests do suggest that teachers must know their physics content in order for them to recognize a need to change. Teachers who are not well prepared in physics might tend to follow the text more closely and focus on covering the content without taking into consideration the local students' needs, experiences and interests.

Test 6 (S): Perceived Degree of Confidence in the Teacher's Physics Knowledge as a Function of the Number of Semesters of Physics Courses Teachers Have.

Given n = 89 participants, the statistical analysis revealed that there is not a statistically significant difference in the perceived degree of confidence in the teacher's physics knowledge across all categories ($F = 1.669$, $p = 0.139$). However, since some categories have few subjects compared to others, the original seven categories were collapsed into four categories to increase the power of the test and the statistical analysis was performed again. Table 5 summarizes the new descriptive information.

Table 5:

Sample Size, Mean Change in Perceived Degree of Confidence in Physics Knowledge, and Standard Deviations for the Number of Semesters of Physics Courses Teachers Have (Collapsed Data)

No. semesters of physics	Sample size	Arithmetic mean	Standard deviation
0 – 2 semesters	23	4.2406	0.6515
3 – 5 semesters	29	4.4057	0.5556
6 – 11 semesters	22	4.6508	0.3601
12 + semesters	15	4.6467	0.3868

The new analysis showed a statistical difference between the reported means ($F = 3.126$, $p = 0.030$), which state the obvious fact that teachers with less academic preparation in physics

have less confidence in their physics knowledge compared to teachers with more physics courses. The fact that this obvious result was found provides evidence that the confidence scale is measuring what it was intended to measure. This might be considered a barometer test for this instrument.

In addition to the previous significant tests, four non-significant tests that showed definite upward or downward trends were noted. We think the mention of these trends is important for future replications of this study: (a) Test 4 (T): Average change in physics content presentation might be connected with the number of physics semesters teachers have, (b) Test 13 (T): Average change in teaching methodology might be connected to text quality as evaluated by the participants, (c) Test 22 (T): Perceived degree of confidence in the teacher's physics knowledge might be connected with the schools' geographical location, and (d) Test 23 (T): Perceived degree of confidence in the teacher's physics knowledge might be connected to the perceived freedom of the participants to modify their teaching methodology.

The rest of the tests were either non-significant or discarded because of heteroscedasticity of the data in an unequal cell size scenario.

Conclusion

The descriptive data for the independent variables provided insight and context about the participants' characteristics. For example, there was a remarkable difference between experience in teaching and experience in physics teaching. The result showed that most physics teachers are relatively inexperienced compared to their total teaching experience. Some possible explanations for this difference were stated. Also, it was found that one in four teachers have less than two semesters of physics, possibly a year of physical sciences or a year of general physics. The

implications of this for teaching quality and the inclusion (or non-inclusion) of contextual and culturally relevant approaches in physics teaching are undeniable. If the 1:3 ratio is representative of all physics teachers in Puerto Rico, as we think it is, then there are a large number of teachers without the deep knowledge necessary to use a contextual and culturally relevant approach effectively in the teaching of physics.

It was also learned about the overcrowding of some physics classrooms and the effect this might have in the quality of teacher instruction, and about how most teachers appear to tailor the physics curriculum to the needs of their students, instead of following the physics curriculum prescribed from the Puerto Rico Department of Education. On the other hand, we saw teachers who think they have no freedom to change their teaching methodologies despite the fact that the Puerto Rico Department of Education leaves this decision to each teacher.

The descriptive information for the dependent variables is also enlightening. We saw how that, for the variable "average change in physics content presentation" the topics that are reported as made more contextual and culturally relevant changes, are usually those taught more frequently in the first semester of the course. Being taught more often, teachers have a good grasp of them and can make the changes. Overall, most of the reported means are larger than three, which suggests that teachers do make appreciable changes to their physics content presentation. For the variable "average change in teaching methodologies", the range of responses was broader, but most of the means are larger than three, which implies that teachers also made changes to their methodologies to make them contextual and culturally relevant. Data from the third dependent variable suggests that a great majority of teachers feel confidence about their physics knowledge.

Results from the univariate test showed that the reported mean change in physics content presentation is statistically related to the teachers' experience teaching physics, class size, and whether they believe have freedom to change their teaching methods. Also, the reported mean change in teaching methodologies is statistically related to gender and academic preparation in physics. The participants' confidence in their physics knowledge was significantly related to their academic preparation in this area. Some of the tests that were not significant are also valuable as a validity tool because no significant relationship was expected and none was found. Some examples of these tests are those related to the schools' geographical location and school size.

It is clear that, based on the quantitative data, there are three or possibly four factors that determine if Puerto Rican high school physics teachers modify the physics curriculum to make it more contextual and culturally relevant to the student population they serve: (a) years of experience teaching physics; (b) class size; (c) whether teachers believed the Department of Education gave them freedom to select and modify their teaching methodology; and (d) academic preparation in physics. Also, there are two or possibly three factors that determine if Puerto Rican high school physics teachers modify their teaching methodology to make it more contextual and culturally relevant to local students: (a) gender; (b) academic preparation in physics; and (c) perceived textbook quality.

Limitations of the Study

Given the characteristics of the study, several shortcomings are apparent. In terms of the quantitative analysis, the sample size of 92 individuals was too small for more powerful tests, like two-way analysis of variance for all two variable combinations, to be performed. Unfortunately, replications of this study might face the same challenge given the number of

Suggestions for Further Research

Given the exploratory nature of this study, many questions were left unanswered. In general, further research should be done to replicate the findings from questions one and two, that is, confirm whether Puerto Rican physics teachers are making their physics content presentation and teaching methodologies contextual and culturally relevant. Special emphasis should be placed on the teachers providing specific, detailed evidence of how and why they make changes in these two areas.

Also, future research might focus on specific cultural aspects of Puerto Rico in the physics class, since the importance and relevance of this component was not completely detailed in this study. A more complex endeavor might be to explore the relationship between the concepts "culture" and context", and if these concepts are differentiable or not. This study identified a number of factors that might influence the teachers' decision of making their physics content and teaching methodology more pertinent. Each one of these factors can be explored in a different study.

References

Cobern, W. W. (1999). Science and a social constructivist view of science education. In William W. Cobern, *Socio-cultural perspectives on science education*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Court, I (1972). In-service training problems in introducing a foreign-based science curriculum into Puerto Rico. *Dissertation Abstracts International, 33*(06), 2783A. (University Microfilms No. AAI72-19813).

Diekhoff, G. (1996). *Basic statistics for the social and behavioral sciences*. Upper Saddle River, NJ: Prentice Hall.

Eliza-Colon, S. M. (1989). Colonialism and education in Puerto Rico: Appraisal of the public schools during the Commonwealth period 1952-1986. *Dissertation Abstracts International, 51*(04), 1139A. (University Microfilms No. AAI90-17364).

SE066327

ERIC

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Proceedings of the 2002 Annual International Conference of the Association for the Education of Teachers in Science

Editors: Peter A. Rubba, James A. Rye, Warren J. DiBiase, & Barbara A. Crawford

Organization: Association for the Education of Teachers in Science

Publication Date: June 2002

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1	Level 2A	Level 2B
[X]	[ ]	[ ]
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, → please

Signature: Peter A. Rubba	Printed Name/Position/Title: Peter A. Rubba, DAP, World Campus	
Organization/Address: Dr. Jon Pederson, AETS Exec. Secretary College of Education, University of Oklahoma 820 Van Velet Oval ECH114 Norman, OK 73019	Telephone: 814-863-3248 E-Mail Address: par4@psu.edu	FAX: 814-865-3290 Date: 10/24/02

(over)